

HORTICULTURAL NOTES ON THE ANGSA NA (*PTEROCARPUS INDICUS* Willd.)

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ABSTRACT

Pterocarpus indicus, a species of Leguminosae and highly adaptable in a variety of habitats, is extensively planted as a shade and ornamental tree in Singapore. Propagation is commonly by woody cuttings and trees of considerable size can be transplanted successfully. Growth rates under mesic habitat conditions are fast. Transplanted stumps of 3.7 m height and 60 cm girth breast height can achieve a height increment of 1.66 m and a girth increment of 14 cm per annum.

General requirements, pest and disease association, phenology, horticultural use of the species, and transplanting technique for large rooted stumps are described.

INTRODUCTION

Pterocarpus is a large genus of trees of the family Leguminosae with distribution throughout the tropics. The Angsana is indigenous to Peninsular Malaysia.* Its natural habitat is said to be on the banks of coastal creeks and rocky shores, but it is not certain whether it occurred in Singapore (Corner, 1952). *Pterocarpus indicus* is extensively cultivated in the Indo-Pacific region as an ornamental tree and for its shade. It has massive limbs, both ascending and spreading, which produce slender, drooping branches. Crowns of trees of various sizes which have not been subjected to pruning or pollarding for some time assume a rounded appearance. Full-sized trees in Singapore measure 25 to 30 m tall with a crown-spread of almost equal dimension and a girth at breast height of 5 – 5.5 m (Fig. 1). There are, however, larger specimens growing in Penang with girths exceeding 6 m. In Singapore there are some old trees along the highways and adorning institutional grounds, but in the past 14 years a vast number of the species has been planted in a great variety of settings, so much so that many young trees are now dominating many local scenes (Figs. 2–5). Its popularity lies in its ease of propagation, fast growth rate, ease of management and, above all, it lends itself to transplanting as a fairly large tree with a high degree of success. Such transplants have been referred to as “instant” trees because branches develop soon after transplanting and within a matter of a few months fair-sized trees obtained.

PROPAGATION

Angsanas can be propagated from seed, however, in view of the ease of propagation by woody cuttings in Singapore, propagation by seed is seldom, if at all, practised. Cuttings of various sizes can be used. The Parks & Recreation Department has planted cuttings of 3 m length, with a lower-end diameter measuring some 10 cm, directly into planting sites with some degree of success. More commonly smaller cuttings are used for rooting

* At the time of printing, the author had resigned.

* Angsana or Sena, as this species is also known in Malay, is also naturally found in India, SE. Asia, Philippines, Sumatra, and Java.

in the nursery before field planting. A suitable cutting is one with a 1.5 m length and 4 to 5 cm diameter at the lower end. The cutting is inserted about 20 cm deep in a soil mixture contained in a polybag 30 x 30 cm. The cutting can be in the form of a straight stake or be treated so that the top end has a few branches. Treatment with a fungicide will ensure greater success — which may be as high as 90%. Such a cutting will flush within 2–4 weeks and be well rooted within 3 months. Cuttings of the size described can also be planted unrooted directly into the field, but the maintenance of such plants (e.g. watering and pest control) spread over a large area is of course more problematic and the percentage of success will be lower.

For the production of “instant” trees, many of the rooted cuttings are planted out in road verges and roadside open spaces. In such areas planting is done at a higher density than required by mature trees so that after a period of growth (about 2 to 3 years) the grove is progressively thinned for transplanting to places where the landscape requires an instant effect for visual impact or for shade.

FIELD PLANTING AND TRANSPLANTING

Small Rooted Cuttings

If propagation is through woody cuttings planted in polybags in the nursery, the rooted cuttings can be transplanted into the field when they are about 3 to 6 months old. A cutting of this age will have produced a bunch of short slender branches at the top end measuring about a metre long. Care should be taken not to break these branches while the plants are being handled for transplanting. For cuttings of the size described it is normal to plant them out in machine-dug holes of 1 m³. The planting technique is similar to planting out a sapling grown in polybags. In Singapore it is essential to provide a good loamy top soil for the planting holes because not only is the in situ soil clayey, but in many a planting situation cut and fill operations could have either reduced the planting site to the parent materials or given rise to filled areas consisting of compacted sub-soil or stiff clay.

“Instant” Trees

Angsanas lend themselves to transplanting as large trees fairly easily and the survival rate is usually as high as 90% provided the trees to be transplanted are not too large. In the earlier days of the Garden City Campaign, trees with girths as large as 100 cm (measured 1 m above ground level) were transplanted. It was, however, observed that such large transplants would not grow well. It is now, therefore, the practice to transplant trees with girths of not more than 60 cm.

The transplanting of such trees needs a small crane mounted on a truck, simply because of their weight and size. A tree of 60 cm girth is, in fact, already 7 m tall. The branches are first lopped off so that the resultant stump with the various snags is about 4.5 m high. The stump should have 3 to 4 main snags for proper crown development. All slender twigs and branches below the pollarded ends or the main branches are removed. The cut surfaces of the pollarded branches are painted with a wound dressing so as to prevent dessication and extensive rotting. This is of particular importance for the Angsana because it has the habit of producing new branches almost flush with the cut surface of the snag or just below it. If rotting occurs, proper callousing may not be achieved and a developing branch will snap easily at the point of union during a storm.

After the tree has been prepared as described above, the next step is to excavate around



Fig 1. Full grown Angsanans near Anderson Bridge. The age of these trees is likely to be about 100 years. They are the remnants of a row destroyed by a disease in 1926. Their present height is approximately 27m. with a girth at breast height of 4.57m.



Fig. 2. Year old transplants of Angsana at Ang Mo Kio Town Centre. Note the feathery appearance of young, mostly ascending, branches at this stage of growth.



Fig 3. Angsanas lining a part of Orchard Mall. These transplants were 4 years old when the photo was taken. Note the fully developed and rounded crowns with drooping branches.



Fig 4. The Margin of the swimming Lagoon at East Coast Park lined with transplants 5 years old.



Fig 5. Six-year old Angsana transplants providing shade to the cycle and jogging tracks at East Coast Park.

the tree base to create a proper ball of earth for eventual lifting. A trench of about 60 cm depth is first dug around the tree base at a distance of about 50 cm from the base of the stump. More earth is removed by undermining towards the trunk so that the ball of earth is shaped like an inverted dome with the original soil surface on top. The ball of earth is wrapped with gunny sacks or some other suitable material so as to prevent the earth from breaking up when the tree is lifted. A chain and choke arrangement attached to a winch with power take-off from the lorry is used to sever the ball of earth from the ground before the tree is lifted by the crane onto the lorry for transportation to the planting site (Fig. 6).

Trenching can be done mechanically, although the shaping of the ball of earth and wrapping it have to be done manually.

What is described has been the practice in Singapore up to now and this careful treatment has ensured a high degree of success in transplanting. In the face of labour shortage

we have tried out some of the transplanting machines available today. The preliminary trials showed that such machines do not give an intact ball of earth because the grabbing and uplifting actions tend to loosen the earth too much, especially when the soil is loamy, thus leading to root disturbance and greater transplanting shock, particularly in our hot tropical climate in which evapo-transpiration is high. The Parks & Recreation Department is using more clayey soil for growing future transplants and for species such as the *Angsana* which has a high regrowth potential, there is a chance that transplanting can be done mechanically.

Theoretically in the transplanting of "instant" trees one should ensure as large a ball of earth as possible so as to preserve a large number of undisturbed roots and rootlets. This will lessen transplanting shock. On the other hand, this will also increase handling costs especially when trenching is done manually. *Angsana* has been found to be a very rugged species which can withstand rough handling. In recent months transplants of 50 cm girths which were lifted with a ball of earth as small as 30 cm radius and 50 cm depth were found to survive well. Further, it has been found that when the ball of earth is very clayey no wrapping is needed and so long as the ball is not disintegrated the stump can still survive.

The hole earmarked to receive the transplant can be 1.5 m square by a metre deep. Enough top soil should be filled in so that it forms a flat-topped mound about 20 cm or so above the original soil surface. It has been found that in transplanting "instant" trees it is best to avoid putting sludge in the planting hole for this has been found to cause higher mortality. One reason may be that the organic matter encourages greater moisture retention leading to fungal infestation of the injured root system of the transplant.

The ball of earth of the transplant is placed so that the original surface is flush with the flat-topped mound. Allowing for settling, the surface of the original ball of earth will be flush with the surrounding land surface in due course. In places where there is a tendency to water-logging a slightly higher mound can be used. One should avoid deep planting which will result in poor plant growth even if the transplant were to survive. For such large transplants there is no necessity to stake, but in areas such as car parks there is a need to provide tree guards to prevent the transplants from being knocked down by cars.

Sometimes during preparation for transplanting, the bark of the stem or snags might be damaged. Should this happen one should use a wood preservative to paint over the injury to prevent rotting. Unless damage is extensive callous formation will soon grow over the wound.

Spacing

If final spacing is considered then the *Angsana* should be given 25 m between trees. However, a planting scheme along roadsides with such spacing will give rise to a rather sparse appearance and will not have a green impact for a long time. It is normal, therefore, for us to plant trees about 12 m apart so that if need be such trees can later be progressively thinned for use elsewhere.

GROWTH
Crown Development

For transplants as “instant” trees, sprouting from near the pollarded tips of the snags takes place within 2 weeks, although this can be as late as 1 month from the date of transplanting. It has also been observed that the early sprouts may suddenly die back, especially during drought, only to be followed by the emergence of fresh shoots which will eventually develop into the main branches of the tree.

The young branches tend to cluster around the pollarded tip. A few, however, may develop a little further down. Unlike the Yellow Flame (*Peltophorum pterocarpum* (DC.) Back.) epicormic shoots are uncommon under normal conditions of growth after transplanting. Within 3 months there can be as many as 10 young branches per snag (pollarded



Fig. 6. Transplanting a large rooted stump. The pollarded stump with its ball of earth is positioned by the crane to go into the planting hole. Since the ball of earth has clayey soil, it has not been wrapped.

branch) which measure about 1.5 m length and assume a feathery appearance. After a year, the lower of these branches spread out while the upper ones become the ascending limbs which increase rapidly in girth and length. Each of these 'primary' branches gives rise to many subsidiary branches, many of which are slender and drooping. After two years a well-formed crown develops. After 4 years, if no subsequent pruning is done, a rounded crown is achieved. Crown density, however, varies from tree to tree, depending on the original number of snags of the transplanted stump and the subsequent shoots which develop therefrom.

Growth of large woody cuttings or rooted cuttings planted out in the field assumes a similar pattern, but because of the smaller initial stature of such plants, growth in size and crown proliferation will understandably be slower.

Bole Development

It has been observed that the original stump does not grow in height after transplanting. Height is contributed by the numerous new branches which develop from the snags of the original stump. The bole, however, increases in girth. At the time of transplanting the bole of a stump of the usual girth size (60 cm) is rounded in cross section but as the bole increases in size, it becomes fluted. The fluting is increasingly pronounced with greater girth size, with the ridges developing into short buttresses at ground level.

The girth measurements presented below have been taken over the fluted boles.

Height & Girth Increments

Quantitative data are not available on height and girth increments of the Angsana because there was no systematic inventory to study growth. However, some figures of growth based on estimates and measurements of a few trees planted in the past 10 years are given here as an indication.

Three trees along Maxwell Road immediately next to the Maxwell Market planted in 1970 have an average girth of 2.15 m, measured 1.5 m above ground level, and a total height of about 17 m. At the time of planting the average girth was about 60 cm and the stump height was about 3.7 m. This means the trees have put on over 11 years an average height increase of 13.3 m and a girth increment of 1.55 m or an equivalent of 1.2 m height, and 14 cm girth growth per annum. These trees now have a crown spread of 12 to 18 m.

Another group of 6 trees growing along Maxwell Road in front of the Tamil School and planted in 1973 have an average girth of 1.63 m, measured 1.5 m above ground and an average height also of 17 m. The other parameters are the same as for the trees mentioned in the preceding paragraph. Calculating in the same way a girth increment of 12.9 cm and a height increment of 1.66 m per annum.

It will be noted that the trees in front of the Tamil School have faster height growth, but slightly smaller girth increments. This could be due to the fact that the spacing of the 2 groups of trees are different since those by the side of the market are spaced 18 m apart while those in front of the school are spaced 12 m apart. The closer spacing in the latter group has caused crown competition to push the trees skywards, while the girth increment is retarded.

Given the right root environment the Angsana grows well and fast, but is sensitive to root-bound conditions. This is shown by the trees growing along the centre divider of Paya Lebar Road. Angsanas stumps of similar sizes were planted there in 1974. Somehow at the time of planting several layers of the old road surfaces were not broken through. In effect, the trees were standing on a concrete surface 1 m below the present road surface and as a result all the trees stagnated. Although they are now 7 years old their average girth is only 0.9 m (0.6 m at the time of planting) or the girth increment was only 4.3 cm per annum compared with the more rapid growth of 14 cm and 12.9 cm girth per annum of the trees mentioned earlier.

Another example of stunted growth is seen in the concourse of the National Development Building where bed rock is near the soil surface and where lateral root spread is further restricted by the concrete surface. Two Angsanas planted there in 1970 have hardly grown, but nevertheless are still alive.

GROWTH REQUIREMENTS

Habitat

The habitats of the Angsana along the East Coast of Peninsular Malaysia are said to be riparian along coastal tidal creeks (Corner, 1952). In Singapore it is one of the most adaptable tree species and is able to grow well in a wide range of habitats and soil conditions. It grows on flat sandy areas near the coast as well as in hilly areas with stiff clay. It is also able to withstand a considerable degree of water-logging as evidenced by its fair performance at the East Coast Park which has reclaimed land with extremely compacted soil. The compaction and the flat topography of the Park cause poor percolation and surface run-off. As a result the planting holes into which loamy top soil has been filled became sumps for rain water. Many other species have failed to establish under such conditions, but the Angsana is able to grow. It is, however, expected that growth will not be as good as that achievable by the individuals under more mesic conditions.

The Angsana is a light demander and is, therefore, not suited for underplanting in an existing grove of trees. Left to compete amongst themselves, Angsana trees can be planted close together or in groves to form good screens or other ornamental features.

Nutrients

Little is known about the exact nutrient requirements of ornamental trees. Our manurial programme is, therefore, a tentative one until more reliable data can be obtained at a later date. One approach is to study the annual litter fall of trees of different ages to gauge the amount of nutrient loss through this factor. In an urban environment it can be assumed that all litter is swept away and the manurial programme should aim at replacing this amount of loss. Further refinement can be achieved through a more quantitative estimate of the stem and branch growth.

The Department has just begun to establish leaf traps in different places to measure annual litter fall for Angsana. Perhaps after a year or so some information can be obtained. Meanwhile, the practice is to apply $\frac{1}{2}$ kg, 1 kg, 1.5 kg of a compound fertilizer to transplants respectively in the 1st, 2nd and 3rd year of growth. Thereafter, application is based on the visual conditions of the trees and the manurial rates can vary between 3-10 kg per annum depending on the size of the trees.

In parks and gardens the fertilizers are broadcast evenly over the soil surface under the tree crown but in roadside situations with concrete sidewalks, the manure is applied in the grooves between concrete slabs or in the holes in the slabs. In such concrete areas it is usually difficult to apply the full rate for a tree of a particular size because of the limited unsealed area of the tree base. The annual rate is, therefore, given in two or more applications.

PESTS & DISEASES

In urban sidewalks, small urban parks, and open spaces the Angsana is particularly free from pests and diseases. When planted in large parks or in areas bordering natural vegetation, foliar damage by pests, mostly grasshoppers (*Valanga*) and night flying beetles (*Apogonia*, *Adoretus*, and *Anomala*), is not uncommon. Occasionally the young leaves can also be damaged by leaf miners.

As the trees grow fast and new flushes are produced continually it is seldom the practice to control pest damage. If, however, young trees produced by short cuttings are badly damaged, an organophosphate such as "Dipterex" can be used for a weekly spray. More persistent pests can be tackled with "Basudin".

The Angsanas planted along Mandai Road and those growing in the Zoological Gardens, both localities being surrounded by forests, suffer from a kind of leaf blight—the fungus of which has been identified as a species of *Gleosporium*. Phenologically the Angsana does shed its leaves occasionally but seldom with the crown completely bare. The trees planted along Mandai Road, however, undergo a cyclical rhythm with the crown completely defoliated by the leaf blight followed by luxuriant new flushes. As the leaves get older, they are afflicted by the same malady and the cycle is repeated. The association of the disease with proximity to the forest is due perhaps to the higher relative humidity associated with such a habitat which favours fungal growth.

Angsana trees in Singapore and Peninsular Malaysia suffered extensive mortality from 1875 to 1925. Trees 10 to 40 years old died progressively and sometimes whole rows were wiped out. It appears the present trees standing near Anderson Bridge along Connaught Drive are remnants of a whole row growing along that road. The disease was never identified. Furtado (1935) noted that the malady could have been spread by a Jassid (leaf hopper) while Corner (1952) stated that the disease was akin to the Dutch Elm Disease of the Temperate Zone.

PHENOLOGY

In the northern part of Peninsular Malaysia where the climate tends to be drier and the dry spells more pronounced, gregarious flowering is said to take place frequently. In Singapore mature trees do not flower often and flowering is normally solitary. One exception to this rule was the general flowering which took place in June/July 1976 when old trees littered the roads with carpets of their fragrant yellow flowers, so much so that special efforts were made to sweep them off daily. Apparently this general flowering was in response to the prolonged and pronounced dry spell which stretched from January to March 1976. For the first time many other flowering trees planted in Singapore also flowered gregariously in response to that stimulus—notably amongst them being *Gliricidia sepium* (Jacq.) Kunth ex Walp., another Leguminous tree.

When a tree flowers, normally a large part of the crown is covered with the flowers

and the whole affair is over within 4 days to a week (Fig. 7). According to Corner (1952) the disc-like fruits take 4 months to mature.

In Singapore, young trees or new transplants assume an evergreen habit when grown under mesic conditions and given adequate manuring. The crown puts on new flushes continually throughout the year. Old trees or younger transplants which are grown under exacting conditions such as in rocky areas with shallow soil, tend to be deciduous at the top of the crown and such trees assume a stag-headed appearance. Strangely enough such trees also tend to flower and fruit slightly more often.

SPECIAL HORTICULTURAL CHARACTERISTICS

Adaptability

As indicated before, Angsana is a tree which lends itself to propagation by large woody cuttings and large transplants. Apart from this, Angsanas are highly adaptable. In Singapore they are now planted in a great variety of habitats ranging from well-drained hill slopes to flat, water-logged reclaimed land.

Aggressive Roots

Perhaps one reason why the Angsana is able to grow well under a wide range of habitats is its powerful root system. It has been observed in trenching operations by Services Departments that the roots are found to be able to spread under road foundations, well beyond the crown limit of the tree, although the soil is very clayey. Figure 8 shows part of the root system of an Angsana tree which proliferated under a service road. A peculiar feature is the presence of anastomosis in the system.



Fig. 7. Inflorescences of the Angsana associated with leafy twigs. The petals are golden-yellow in colour.

In many instances the roots have been found to grow underneath large concrete monsoon drains and then emerge in the surface of lawns located some distance from the base of the tree. Such rugged root systems mean that it is able to exploit nutrient and moisture resources over a wide area, hence the vigorous growth.

Response to Pruning, Pollarding, or Crown Damage

The Angsana is able to recover from pruning or pollarding very quickly. This has advantages in horticulture, but at the same time poses a problem to the management of roadside trees. In areas where the trees need pruning it is desirable aesthetically that the crown recovers its shape rapidly; on the other hand, this means higher frequency of pruning or pollarding to ensure the branches will not get into the way of traffic (especially buses and containers).

In May 1976, during a severe thunderstorm, the crown of a large tree was severely damaged. After the usual tree surgery to harmonise the branching and to prevent rotting, the tree put on new flushes within a couple of weeks and 7 months later had reformed a well-shaped crown.

The Production of Adventitious Roots in Response to Injury

It has been observed that the Angsana has another very interesting characteristic in that, for mature or old trees extensive injury to any part of the trunk or stem causes the callousing bark to produce adventitious fibrous roots which can be extensive and matted. Likewise, fibrous roots are produced in the arch of a cracked bifurcation. The roots grow in size and number rapidly within the crack, presumably because of the collection of water and nutrients therein, thus causing the two arms of the bifurcation to be forced apart. If this happens to be between the main ascending limbs it is most dangerous for it is only a matter of time before one of them collapses. It is, therefore, better to have such a tree felled or proper bracing must be carried out. If the phenomenon occurs in a less critical part of the tree, then that portion should be pruned off.

GENERAL HORTICULTURAL USE

The Angsana is certainly a graceful tree with considerable ornamental value and because of its large size it also provides good shade. It is a tree for open spaces and wide sidewalks or centre dividers where shade is important and needed quickly. It is also a tree to be chosen where the edaphic conditions are too exacting for establishing other trees, i.e. if space permits the planting of such a tree. It is not recommended for narrow sidewalks or in small home gardens, not only because of its big size, but also because of the aggressive roots. For any particular landscape which needs an "instant" effect, the Angsana can be used judiciously, but because of the ease of transplant and fast growth, the Angsana has been chosen for many localities where it should not have been planted.

Angsana root systems are wind-firm, but the young branches of transplants tend to snap in stormy weather at the point of union with the pollarded branches. Smaller rooted stumps with smaller pollarded snags tend to give better union and hence more wind resistance.



Fig. 8. Vigorous roots of a 25-year old Angsana under a service road. Note the unusual phenomenon of anastomosis of the roots. The tree was grown from a seedling.